

WHAT IS CLAIMED IS:

1. A fuel cell comprising:
 - a casing;
 - a cathode having a first surface and a second surface;
 - at least part of the second surface being exposed to the atmosphere;
 - an anode having a first surface and a second surface;
 - a first chamber configured to retain liquid fuel, wherein the first chamber is defined at least partially by the first surface of the anode; and
 - a second chamber configured to retain liquid electrolyte, wherein the second chamber is defined at least partially by the second surface of the anode and the first surface of the cathode,wherein the fuel cell is configured to be sealed in a substantially liquid-tight manner during at least a portion of its service life.
2. The fuel cell of claim 1, wherein the fuel cell is configured to be disconnected from a fuel delivery system during at least a portion of the service life.
3. The fuel cell of claim 1, wherein the casing is configured to be substantially liquid-tight regardless of orientation.
4. The fuel cell of claim 1, wherein the first chamber is filled at least partially with a liquid fuel and the second chamber is filled at least partially with a liquid electrolyte.
5. The fuel cell of claim 4, wherein the liquid fuel comprises a lower alcohol.

6. The fuel cell of claim 4, wherein the liquid fuel comprises at least one of LiAlH_4 , KBH_4 , NaBH_4 , LiBH_4 , $(\text{CH}_3)_3\text{NHBH}_3$, NaAlH_4 , NaCNBH_3 , CaH_2 , LiH , NaH , KH , $\text{Na}_2\text{S}_2\text{O}_3$, Na_2HPO_3 , Na_2HPO_2 , $\text{K}_2\text{S}_2\text{O}_3$, K_2HPO_3 , K_2HPO_2 , NaCOOH and KCOOH .

7. The fuel cell of claim 4, wherein the liquid electrolyte comprises an aqueous inorganic hydroxide.

8. The fuel cell of claim 1, wherein the cathode comprises an air-breathing cathode.

9. The fuel cell of claim 1, wherein the anode comprises a metal that is capable of catalyzing an electrochemical oxidation of the liquid fuel.

10. The fuel cell of claim 1, wherein the fuel cell lacks a membrane.

11. The fuel cell of claim 1, wherein the first chamber is configured to retain about 2000 ml of liquid fuel.

12. The fuel cell of claim 11, wherein the first chamber is configured to retain from between about 1 to about 1000 ml of liquid fuel.

13. The fuel cell of claim 1, wherein the second chamber is configured to retain up to about 1000 ml of liquid electrolyte.

14. The fuel cell of claim 13, wherein the second chamber is configured to retain from between about 0.5 to about 500 ml of liquid electrolyte.

15. The fuel cell of claim 1, wherein the casing has a generally rectangular outer shape.

16. The fuel cell of claim 15, wherein a largest outer dimension of the casing is less than or equal to about 50 cm.

17. The fuel cell of claim 1, wherein the fuel cell comprises a free inner volume of about 4000 ml.

18. The fuel cell of claim 17, wherein the free inner volume is between about 1.5 and about 3000 ml.

19. The fuel cell of claim 1, wherein at least one of the cathode and the anode comprises a surface area of between about 0.5 and about 500 cm².

20. The fuel cell of claim 1, wherein at least a portion of the casing comprises a plastic material.

21. The fuel cell of claim 20, wherein the plastic material comprises at least one of polyolefin, polycarbonate, polyvinylchloride, acrylonitrile-butadiene-styrene terpolymer, polyurethane, polytetrafluoroethylene and silicone rubber.

22. The fuel cell of claim 1, wherein at least a portion of the casing comprises at least one of a metal and a metal alloy.

23. The fuel cell of claim 22, wherein at least a portion of the casing comprises at least one of stainless steel, nickel, chromium and titanium.

24. The fuel cell of claim 1, wherein the casing comprises at least one sealable opening communicating with each of the first and second chambers.

25. The fuel cell of claim 1, wherein the casing comprises ports which are configured for multiple opening and resealing operations.

26. The fuel cell of claim 1, wherein the casing comprises two sealable openings in fluid communication with each of the first and second chambers.

27. The fuel cell of claim 26, wherein each the two sealable openings comprises oppositely arranged openings.

28. The fuel cell of claim 1, wherein the casing comprises valves.

29. The fuel cell of claim 1, wherein the second surface of the anode and the first surface of the cathode are substantially parallel to each other.

30. The fuel cell of claim 1, wherein the fuel cell comprises one first chamber and one second chamber.

31. The fuel cell of claim 1, wherein the fuel cell comprises one first chamber and two second chambers.

32. The fuel cell of claim 1, wherein the fuel cell comprises two first chambers and two second chambers.

33. The fuel cell of claim 1, wherein the fuel cell comprises at least another cathode, at least another anode, and another second chamber for retaining liquid electrolyte.

34. The fuel cell of claim 33, wherein the fuel cell comprises another anode, another cathode, a single first chamber and another second chamber.

35. The fuel cell of claim 34, wherein the second chamber is defined by the anode and the cathode and wherein the other second chamber is defined by the other anode and the other cathode.

36. The fuel cell of claim 1, wherein the casing comprises at least one sealable opening for allowing gas generated during an operation of the fuel cell to escape to the atmosphere.

37. The fuel cell of claim 1, wherein the fuel cell further comprises an ancillary power supply device for peak power requirements.

38. The fuel cell of claim 37, wherein the ancillary power supply device comprises a supercapacitor.

39. A self-contained, refillable fuel cell comprising:
a cathode having a first surface and a second surface, at least part of the second surface being exposed to the atmosphere;
an anode having a first surface and a second surface;
a first chamber filled at least partially with a liquid fuel, the first chamber being defined at least partially by the first surface of the anode;
a second chamber filled at least partially with a liquid electrolyte, the second chamber being defined at least partially by the second surface of the anode and the first surface of the cathode;
at least one sealable opening communicating with the first chamber; and
at least one other sealable opening communicating with the second chamber,

wherein the fuel cell is configured to at least one of receive fresh liquid and discharge spent liquid via the sealable openings.

40. The fuel cell of claim 39, wherein the first and second chambers each communicate with two sealable openings, one for discharging spent liquid and one receiving fresh liquid.

41. A cartridge for refreshing the fuel cell of claim 39, wherein the cartridge comprises at least one of a fuel chamber at least partially filled with liquid fuel and an electrolyte chamber at least partially filled with liquid electrolyte.

42. The cartridge of claim 41, wherein the cartridge comprises each of the fuel chamber and the electrolyte chamber and wherein the fuel and electrolyte chambers are each in fluid communication with at least one sealable opening.

43. The cartridge of claim 42, wherein the fuel and electrolyte chambers are each in fluid communication with two oppositely arranged sealable openings.

44. The cartridge of claim 43, wherein each sealable opening comprises a valve.

45. The cartridge of claim 41, wherein the liquid fuel comprises a lower alcohol.

46. The cartridge of claim 45, wherein the lower alcohol comprises at least one of methanol and glycerol.

47. The cartridge of claim 45, wherein the liquid fuel comprises at least one of LiAlH_4 , KBH_4 , NaBH_4 , LiBH_4 , $(\text{CH}_3)_3\text{NHBH}_3$, NaAlH_4 , NaCNBH_3 , CaH_2 , LiH , NaH , KH , $\text{Na}_2\text{S}_2\text{O}_3$, Na_2HPO_3 , Na_2HPO_2 , $\text{K}_2\text{S}_2\text{O}_3$, K_2HPO_3 , K_2HPO_2 , NaCOOH and KCOOH .

48. The cartridge of claim 41, wherein the liquid electrolyte comprises an aqueous hydroxide.

49. The cartridge of claim 48, wherein the aqueous hydroxide comprises potassium hydroxide.

50. The cartridge of claim 41, wherein the fuel chamber is configured to retain up to about 2500 ml of liquid fuel.

51. The cartridge of claim 50, wherein the fuel chamber is configured to retain from about 1.5 to about 1250 ml of liquid fuel.

52. The cartridge of claim 41, wherein the electrolyte chamber is configured to retain up to about 1500 ml of liquid electrolyte.

53. The cartridge of claim 52, wherein the electrolyte chamber is configured to retain from about 1 to about 750 ml of liquid electrolyte.

54. The cartridge of claim 41, wherein the cartridge comprises a generally rectangular outer shape.

55. The cartridge of claim 54, wherein a largest outer dimension of the cartridge is not larger than about 50 cm.

56. The cartridge of claim 41, wherein the cartridge comprises a free inner volume which is equal to or less than about 5000 ml.

57. The cartridge of claim 56, wherein the free inner volume is between about 2 to about 4000 ml.

58. The cartridge of claim 41, wherein at least a portion of the cartridge comprise a plastic material.

59. The cartridge of claim 58, wherein the plastic material comprises at least one of polyolefin, polycarbonate, polyvinylchloride, acrylonitrile-butadiene-styrene terpolymer, polyurethane, polytetrafluoroethylene and silicone rubber.

60. The cartridge of claim 41, wherein the cartridge comprises one fuel chamber and one electrolyte chamber.

61. The cartridge of claim 41, wherein the cartridge comprises one fuel chamber and two electrolyte chambers.

62. The cartridge of claim 41, wherein the cartridge comprises two fuel chambers and two electrolyte chambers.

63. A packaged combination of a plurality of cartridges for refreshing the fuel cell of claim 39, wherein the combination comprises at least one first cartridge filled at least partially with liquid fuel and at least one second cartridge filled at least partially with liquid electrolyte.

64. The packaged combination of claim 63, wherein the combination comprises between about 1 and about 20 first cartridges and one second cartridge.

65. The combination of the fuel cell of claim 39 and a cartridge for refreshing at least one of the liquid fuel and the liquid electrolyte of the fuel cell.

66. The combination of claim 65, wherein the cartridge comprises at least one of a fuel chamber and an electrolyte chamber.

67. The combination of claim 66, wherein at least one of the fuel and electrolyte chambers of the fuel cell and at least one of the fuel and electrolyte chambers of the cartridge are in fluid communication with at least one sealable opening.

68. The combination of claim 67, wherein the at least one sealable opening of one of the fuel and electrolyte chambers of the fuel cell and the at least one sealable opening of one of the fuel and electrolyte chambers of the cartridge are capable of forming a liquid-tight passageway between the fuel cell and the cartridge.

69. The combination of claim 67, wherein each of the fuel and electrolyte chambers of the fuel cell and each of the fuel and electrolyte chambers of the cartridge are in fluid communication with two sealable openings.

70. The combination of claim 68, wherein the cartridge is configured to receive spent liquid fuel and spent liquid electrolyte from the fuel cell via the at least one sealable openings and is configured to introduce fresh liquid fuel and fresh liquid electrolyte into the fuel cell via the at least one sealable openings.

71. The combination of claim 66, wherein a volume ratio of one of the fuel and electrolyte chambers of the fuel cell relative to one of the fuel and electrolyte chambers of the cartridge is between about 1:1 and about 1: 1.4.

72. The combination of claim 66, wherein a volume ratio of liquid contained in the fuel cell relative to liquid contained in the cartridge is between about 1:1 and about 1: 1.4.

73. The combination of claim 66, wherein the cartridge comprises a pumping mechanism for causing liquid in the cartridge to enter the fuel cell.

74. A method of supplying electrical energy to a device, comprising providing a fuel cell comprising a cathode having a first surface and a second surface, at least part of the second surface being exposed to the atmosphere, an anode having a first surface and a second surface, a first chamber containing a liquid fuel, the first chamber being defined at least partially by the first surface of the anode, and a second chamber containing a liquid electrolyte, the second chamber being defined at least partially by the second surface of the anode and the first surface of the cathode; and

electrically connecting the fuel cell to the device,

wherein the fuel cell is sealed in a substantially liquid-tight manner and is not connected to an external fuel delivery system while the fuel cell supplies electrical energy to the device.

75. The method of claim 74, wherein the liquid fuel comprises a lower alcohol.

76. The method of claim 75, wherein the liquid fuel comprises at least one of LiAlH_4 , NaBH_4 , KBH_4 , LiBH_4 , $(\text{CH}_3)_3\text{NHBH}_3$, NaAlH_4 , NaCNBH_3 , CaH_2 , LiH , NaH , KH , $\text{Na}_2\text{S}_2\text{O}_3$, Na_2HPO_3 , Na_2HPO_2 , $\text{K}_2\text{S}_2\text{O}_3$, K_2HPO_3 , K_2HPO_2 , NaCOOH and KCOOH .

77. The method of claim 74, wherein the liquid electrolyte comprises an aqueous inorganic hydroxide.

78. The method of claim 74, wherein the cathode comprises an air-breathing cathode.

79. The method of claim 74, wherein the device is a portable device.

80. The method of claim 74, wherein the device is an electronic device.

81. The device of claim 74, wherein the device is a telecommunications device.

82. The method of claim 74, wherein the device is at least one of a cellular phone, portable computer, PDA, audio device, video device, medical device and a component thereof.

83. The combination of a device and a fuel cell connected to the device wherein the fuel cell comprises a cathode having a first surface and a second surface, at least part of the second surface being exposed to the atmosphere, an anode having a first surface and a second surface, a first chamber containing a liquid fuel, the first chamber being defined at least partially by the first surface of the anode, and a second chamber containing a liquid electrolyte, the second chamber being defined at least partially by the second surface of the anode and the first surface of the cathode, wherein the fuel cell is sealed in a substantially liquid-tight manner and is not connected to an external fuel delivery system.

84. The combination of claim 83, wherein the liquid fuel comprises a lower alcohol.

85. The combination of claim 83, wherein the liquid fuel comprises at least one of LiAlH_4 , KBH_4 , NaBH_4 , LiBH_4 , $(\text{CH}_3)_3\text{NHBH}_3$, NaAlH_4 , NaCNBH_3 , CaH_2 , LiH , NaH , KH , $\text{Na}_2\text{S}_2\text{O}_3$, Na_2HPO_3 , Na_2HPO_2 , $\text{K}_2\text{S}_2\text{O}_3$, K_2HPO_3 , K_2HPO_2 , NaCOOH and KCOOH .

86. The combination of claim 83, wherein the liquid electrolyte comprises an aqueous hydroxide.

87. The combination of claim 83, wherein the cathode comprises an air-breathing cathode.

88. The combination of claim 83, wherein the device is a portable telecommunications device.

89. The combination of claim 83, wherein the device has a power capacity of up to about 150 W.

90. The combination of claim 83, wherein the device is at least one of a cellular phone, portable computer, PDA, audio device, video device, medical device and a component thereof.

91. A method of refreshing a self-contained fuel cell wherein the fuel cell comprises a cathode having a first surface and a second surface, at least part of the second surface being exposed to the atmosphere, an anode having a first surface and a second surface, a first chamber containing a liquid fuel, the first chamber being defined at least partially by the first surface of the anode, a second chamber containing a liquid electrolyte, the second chamber being defined at least partially by the second surface of the anode and the first surface of the cathode, wherein the method comprises:

connecting a cartridge to the fuel cell,

wherein the cartridge comprises a fuel chamber that is filled at least partially with the liquid fuel and an electrolyte chamber that is filled at least partially with the liquid electrolyte.

92. The method of claim 91, wherein the process further comprises coupling sealable openings of the cartridge with corresponding sealable openings of the fuel cell to establish substantially liquid-tight passageways between the cartridge and fuel cell and allowing liquid contained in the cartridge to flow into the fuel cell and *vice versa*.

93. A fuel cell system comprising:

a fuel cell assembly comprising a cathode having a first surface and a second surface, at least part of said second surface being exposed to air, an anode having a first surface and a second surface, a first chamber configured for containing a liquid fuel, said first chamber being defined at least partially by said first surface of said anode, wherein said first chamber has a first liquid transfer port and a second liquid transfer port, said first and second ports being normally closed, a second chamber configured for containing a liquid electrolyte, said second chamber being defined at least partially by said second surface of said anode and said first surface of said cathode, wherein said second chamber has a third liquid transfer port and a fourth liquid transfer port, said third and said fourth ports being normally closed ; and

a cartridge removably connected to the fuel cell.

94. The system of claim 93, wherein each of said first, second, third and fourth ports are configured to open when the cartridge is connected to the fuel cell and are configured to close when the cartridge is disconnected from the fuel cell.

95. The system of claim 93, wherein fuel cell is configured to receive liquid fuel and electrolyte from the cartridge at a bottom portion of the fuel cell and is configured to discharge liquid fuel and electrolyte from a top portion of the fuel cell.

96. The system of claim 93, further comprising a turbulence reducing arrangement disposed within said first chamber, whereby the turbulence reducing arrangement is configured to reduce flow turbulence within said first chamber.

97. The system of claim 96, wherein said turbulence reducing arrangement includes a layer of permeable material.

98. The system of claim 93, wherein the cartridge comprises a first docking port and a second docking port, wherein the fuel cell comprises a third docking port and a fourth docking port, and wherein said first and second docking ports are configured to be respectfully connected to said third and said fourth docking ports.

99. The system of claim 93, further comprising at least one absorbent member arranged within a fluid communication passage between the fuel cell and the cartridge.

100. The system of claim 99, wherein the at least one absorbent member is disposed within at least one of said, first, second, third and fourth docking ports, whereby the at least one absorbent member has an absorbency capacity.

101. The system of claim 93, further comprising a locking mechanism for locking together the cartridge and the fuel cell.

102. A fluid replacement system for replacing a spent liquid contained in a fuel cell having a plurality of refilling ports, the fluid replacement system comprising;

- a storage chamber configured to contain a first replacement liquid;
- a first port in fluid communication with said storage chamber, said first port being connectable with one of the plurality of refilling ports;
- a second port in fluid communication with said storage chamber, said second port being connectable with another of the plurality of refilling ports; and
- a fluid flow actuating arrangement configured to remove at least part of spent liquid from the fuel cell via said second port and to supply at least some replacement liquid to the fuel cell via said first port.

103. The system of claim 102, wherein said replacement liquid is a liquid fuel for a fuel cell.

104. The system of claim 102, wherein said storage chamber is formed primarily from polymer materials.

105. The system of claim 102, wherein said storage chamber has parallel walls and said fluid flow actuating arrangement includes at least one piston configured to move within said storage chamber.

106. The system of claim 102, wherein said fluid flow actuating arrangement comprises at least one piston and at least one spring, wherein the at least one piston acts to substantially separate spent liquid from the fuel cell and replacement liquid.

107. The system of claim 106, wherein the at least one piston is biased by the at least one spring and said fluid flow actuating arrangement further comprises

a retaining arrangement configured to retain and actuatably release said at least one piston.

108. The system of claim 102, wherein said fluid flow actuating arrangement comprises a safety lock configured to prevent an accidental actuation.

109. The system of claim 102, further comprising a first absorbent member disposed in an area of said first port and a second absorbent member disposed in an area of said second port.

110. The system of claim 102, further comprising an interlocking mechanism for maintaining fluid tight connections between the fuel cell and the fluid replacement system.

111. The system of claim 102, wherein said fluid replacement assembly comprises a second storage chamber configured to contain a second replacement liquid, a third port which is operationally connected to said second storage chamber, a fourth port, and a second fluid flow actuating arrangement.

112. The system of claim 111, wherein said second replacement liquid is an electrolyte for a fuel cell.

113. A port arrangement for transferring a liquid between a fuel cell and a cartridge, the arrangement comprising:

a first port;

a second port;

said first port and said second port being configured to open when said first port and said second port are connected together;

an absorbent member disposed between said first port and said second port;

said absorbent member has an absorbency capacity;
said first port and said second port together defining a dead space and being configured to close when disconnected from each other;
said dead space having a volume which is less than or equal to an absorbency capacity of said absorbent material.

114. A liquid replacement method comprising:
at least partially removing an at least partially spent liquid fuel from a first chamber of a fuel cell; and
transferring a replacement liquid fuel into said first chamber,
wherein said removing and said transferring occur substantially simultaneously.

115. The method of claim 114, wherein said removing and said transferring occur without mixing of said at least partially spent liquid fuel and said replacement liquid fuel.

116. The method of claim 114, wherein said removing and said transferring utilize substantially laminar fluid flow within said first chamber.

117. The method of claim 114, further comprising:
at least partially removing an at least partially spent electrolyte from a second chamber of said fuel cell; and
transferring a replacement electrolyte into said second chamber,
wherein said removing and said transferring occur substantially simultaneously.